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(54) **SYSTEM AND METHOD FOR MODEL BASED AND MAP BASED THROTTLE POSITION DERIVATION AND MONITORING**

SYSTEM UND VERFAHREN FÜR MODELLBASIERTE UND KARTENGESTÜTZTE DROSSELKLAPPENABWEICHUNG UND -ÜBERWACHUNG

SYSTÈME ET PROCÉDÉ POUR DÉTERMINATION ET SURVEILLANCE DE POSITION D'UN PAPILLON DES GAZ SUR LA BASE D'UN MODÈLE ET SUR LA BASE D'UNE CARTE

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Description

BACKGROUND

[0001] The subject matter disclosed herein relates to controlling an engine, and, more particularly, to producing a desired engine load (e.g., torque) by applying model based techniques.

[0002] This section is intended to introduce the reader to various aspects of art that may be related to various aspects of the present disclosure, which are described and/or claimed below. This discussion is believed to be helpful in providing the reader with background information to facilitate a better understanding of the various aspects of the present disclosure. Accordingly, it should be understood that these statements are to be read in this light, and not as admissions of prior art.

[0003] Engines (e.g., internal combustion engines such as reciprocating engines or gas turbines) combust a mixture of fuel and air to generate combustions gases that apply a driving force to a component of the engine (e.g., to move a piston or drive a turbine). To achieve a desired engine load, such as torque output, engines may use a throttle to regulate the amount of air and fuel entering the engine. Typically, the position of the throttle may be calculated given the desired torque and engine speed based on known throttle positions that result in the desired torque that produces the desired engine speed. However, determining the throttle position in such a way does not take into account various factors and may result in a slow throttle control response.

[0004] US2014116376 A1 discloses a cylinder intake airflow quantity estimation apparatus of an internal combustion engine.

BRIEF DESCRIPTION

[0005] The solution is provided by the features as defined in claim 1 or the corresponding method claim 10.

[0006] In one embodiment, an engine system may include an engine control system configured to receive a first pressure signal transmitted from a first pressure sensor disposed downstream from a throttle valve, receive a first temperature signal transmitted from a first temperature sensor disposed downstream from the throttle valve, derive a first pressure representative of the first pressure signal, derive a first temperature representative of the first temperature signal, derive a desired air-fuel mixture flow through the throttle valve, derive a first throttle position using a model, wherein the model is configured to use the desired air-fuel mixture flow, the first pressure, and the first temperature as model input, derive a second throttle position using a map, compare the first throttle position to the second throttle position, and apply the first throttle position to control the throttle valve when the first throttle position and the second throttle position are within one or more calibrated thresholds. In one embodiment, a method may include receiving, via a processor, a first pressure signal transmitted from a first pressure sensor disposed downstream from a throttle valve, receiving, via the processor, a first temperature signal transmitted from a first temperature sensor disposed downstream from the throttle valve, deriving, via the processor, a first pressure representative of the first pressure signal, deriving, via the processor, a first temperature representative of the first temperature signal, deriving, via the processor, a desired air-fuel mixture flow through the throttle valve, deriving, via the processor, a first throttle position using a model, wherein the model is configured to use the desired air-fuel mixture flow, the first pressure, and the first temperature as model input, deriving, via the processor, a second throttle position using a map, comparing, via the processor, the first throttle position to the second throttle position, and applying the first throttle position to control the throttle valve when the first throttle position and the second throttle position are within one or more calibrated thresholds.

[0007] In one embodiment, a tangible, non-transitory, computer-readable medium may include instructions encoded thereon. The instructions, when executed by a processor, may be configured to receive a first pressure signal transmitted from a first pressure sensor disposed downstream from a throttle valve, receive a first temperature signal transmitted from a first temperature sensor disposed downstream from the throttle valve, derive a first pressure representative of the first pressure signal, derive a first temperature representative of the first temperature signal, derive a desired air-fuel mixture flow through the throttle valve, derive a first throttle position using a model, wherein the model is configured to use the desired air-fuel mixture flow, the first pressure, and the first temperature as model input, derive a second throttle position using a map, compare the first throttle position to the second throttle position, and apply the first throttle position to control the throttle valve when the first throttle position and the second throttle position are within one or more calibrated thresholds.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] These and other features, aspects, and advantages of the present disclosure will become better understood when the following detailed description is read with reference to the accompanying drawings in which like characters represent like parts throughout the drawings, wherein:

FIG. 1 illustrates a schematic diagram of an engine including a control system controlling a throttle position via model and map based control, in accordance with an embodiment;

FIG. 2 illustrates a schematic diagram of a model of a throttle and connections immediately upstream and downstream of the throttle, in accordance with an embodiment;

FIG. 3 illustrates a flow diagram of a process suitable for deriving a model based throttle position and monitoring the model based throttle position derivation with a derived map based throttle position, in accordance with an embodiment; and

FIGS. 4A and 4B illustrate a schematic diagram of a system using model based and map based throttle position derivation and monitoring to control engine load, in accordance with an embodiment.

DETAILED DESCRIPTION

[0009] One or more specific embodiments of the present disclosure will be described below. In an effort to provide a concise description of these embodiments, all features of an actual implementation may not be described in the specification. It should be appreciated that in the development of any such actual implementation, as in any engineering or design project, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which may vary from one implementation to another. Moreover, it should be appreciated that such a development effort might be complex and time consuming, but would nevertheless be a routine undertaking of design, fabrication, and manufacture for those of ordinary skill having the benefit of this disclosure.

[0010] When introducing elements of various embodiments of the present disclosure, the articles "a," "an," "the," and "said" are intended to mean that there are one or more of the elements. The terms "comprising," "including," and "having" are intended to be inclusive and mean that there may be additional elements other than the listed elements.

[0011] The present disclosure is directed to systems and methods for more accurately controlling a throttle position in an engine to generate a desired torque. It should be noted that throttle position may refer to the angle of a throttle plate inside a throttle body, or an amount of throttle throw or throttle travel. The techniques may derive the throttle position with one or more models of a throttle that account for numerous factors, such as boost to intake manifold pressure ratio, intake manifold pressure, intake air temperature, air fuel ratio, fuel quality (fuel heating value), engine operation efficiency, and so forth. In some embodiments, the factors may be obtained via one or more sensors, input from a user, automatically derived, or obtained by any other techniques. The techniques described herein may more reliably provide for throttle control, even in situations where sensors experience undesired maintenance conditions.

[0012] For example, a two dimensional (2D) map based throttle position derivation may be used to monitor the model based throttle derivation. The 2D map based throttle position derivation may be more robust than the model based throttle position derivation because the 2D map may not use as much (or any) sensor data, but the 2D map may derive a less accurate throttle position than the model. Accordingly, the 2D map based throttle position derivation may be used to crosscheck the throttle position derived using the model. That is, the 2D map based throttle position derivation and the model based throttle position derivation may be compared continuously, periodically, or at any desirable rate. If the derivations are within certain calibrated thresholds, then the model based throttle derivation may be used to control the engine load (e.g., engine torque). If the derivations deviate by more than the calibrated thresholds, for longer than a calibrated time period, or some combination thereof, then a throttle monitor fault may be set and one or more fault response procedures may be triggered to handle the fault. In some embodiments, the one or more fault response procedures may include using the smaller value between the map based and the model based throttle position derivations, shutting down the engine when the fault lasts more than a calibrated time period and/or when the map based and model based throttle position derivations deviate more than the calibrated threshold amount, sending an alert to a workstation, sounding an alarm, or some combination thereof.

[0013] Benefits of the disclosed techniques may include providing a more accurate derivation of throttle position for a desired torque by using sensor data included in a physical model of the throttle than using a map based throttle derivation alone. Also, the model based throttle position derivation may provide faster control response, higher sensitivity during turbocharger initiation, and more consistent engine performance when operational and environmental conditions change. However, as may be appreciated, in some instances, if any of the sensors providing data to the model are unresponsive, or several sensors have drifts but are still within their operating range, then the model based throttle position derivation may be undesirably affected. Thus, a robust map based throttle position derivation may be used to crosscheck and verify that the model based throttle position derivation is reasonable. In this way, the techniques may leverage the better control from the model based throttle position derivation and still maintain the robustness of the map based throttle position derivation.

[0014] Turning now to the drawings and referring to FIG. 1, a schematic diagram of an embodiment of an engine 10 including a control system 12 controlling a throttle 14 position is illustrated. The engine 10 may include a reciprocating or turbine engine (e.g., internal combustion engine). The engine 10 may include a spark-ignition engine or a compression-ignition engine. The engine 10 may include a natural gas engine, gasoline engine, diesel engine, or dual fuel engine. The engine 10 may be a two-stroke engine, three-stroke engine, four-stroke engine, five-stroke engine, or six-stroke engine. The engine 10 may also include any number of cylinders 16 (e.g., 1-24 cylinders or any other number of cylinders) and associated piston and liners. The engine 10 may be

used in a vehicle, such as a locomotive, an automobile, a bus, or a boat. Alternatively, the engine 10 may be used in a stationary system coupled to an electrical generator.

[0015] The engine 10 may include an intake manifold 18 and an exhaust manifold 20. In some embodiments, the engine 10 may also include a charge cooler 22 (e.g., a heat exchanger) and an intake plenum 24. The illustrated charge cooler 22 includes a fluid connection to a compressor 26. The engine 10 may also include a turbocharger 28 driven by exhaust gas. The compressor 26 compresses an oxidant (e.g., intake air) 30 for intake into the intake manifold 18 after cooling by the charge cooler 22 and pressurization in the intake plenum 24. Fuel 32 may be injected and combined with the air 30 by opening a manual regulator 34. The manual regulator 34 may regulate the amount and flow of the fuel 32 entering the engine 10. In some embodiments, the engine 10 may include two options for adding fuel 32 to the air 30. The first may include a draw through option 36 and the second may include a blow through option 38. Using the draw through option 36 the fuel 32 and air 30 may be mixed prior to compression, cooling, and pressurization before being sent to the intake manifold 18, and using the blow through option 38 the fuel 32 may be mixed with the air 30 right before entering the intake manifold 18. A sealed fuel shutoff valve 40 may terminate the flow of fuel 32 into the engine 10 when closed as desired.

[0016] The air-fuel mixture is allowed to flow through the throttle 14 based on the throttle 14 position set by the control system 12 according to the amount of torque desired to maintain a certain speed of the engine 10. The air-fuel mixture flows through the throttle 14 at the desired flow rate and into the intake manifold 18, which evenly distributes the air-fuel mixture to the cylinders 16. Once in the cylinders 16, the air-fuel mixture combusts to generate hot combustion gases, which flow downstream through the exhaust manifold 20 into a turbocharger 28. For example, the combustion gases move through the turbocharger 28 to drive the turbocharger 28 to rotate, which in turn may increase engine 10 efficiency and power by driving extra air into, for example, a compressor 26. The compressor 26 may compress the intake air charge to produce boost. After passing through the turbocharger 28, the hot combustion gases may vent as exhaust gases 41. Also, as depicted, the engine may include a wastegate 42 valve that diverts exhaust gases away from the turbocharger 28 to regulate the turbocharger 28 speed.

[0017] The control system 12 may be connected to one or more sensors 43 and devices throughout the engine 10. For example, the illustrated control system 12 is coupled at least to the throttle 14 and the sensors 43 that are upstream and downstream of the throttle 14. That is, the sensors 43 may be located proximate to the entrance and exit of the throttle 14 (e.g., in between the intake plenum 24 and the throttle 14 and in between the throttle 14 and the intake manifold 18). The sensors 43 may include atmospheric and engine sensors, such as pressure sensors, temperature sensors, speed sensors, and so forth. For example, the sensors 43 may include knock sensors, NO_X sensors, oxygen or lambda sensors, engine air intake temperature sensors, engine air intake pressure sensors, jacket water temperature sensors, engine exhaust temperature sensors, engine exhaust pressure sensors, and so forth. Other sensors 43 may also include compressor 26 inlet and outlet sensors 43 for temperature and pressure. It should be understood that the arrangement of the sensors 43 enable providing signals to the control system 12 indicative of pressure and temperature upstream and downstream from the throttle 14.

[0018] In some embodiments, the control system 12 may include one or more processors 44 and one or more tangible, non-transitory computer-readable media (memories 45) that store computer instructions that perform the disclosed techniques. Also, the control system 12 may include various modules that perform specific functionality, such as an intake controller 46, an engine torque controller (TQC) 48, an engine speed and torque requester (REQ) 50, and so forth. The intake controller 46 may provide functionality to derive a throttle position using fluid dynamic models 60 (e.g., physics based models) of a throttle 14 based on pressure and/or temperature data obtained by the sensors 43 and a desired total flow of the air-fuel mixture through the throttle 14. The model 60 used to derive the throttle position may accept inputs from the TQC 48, such as a desired torque, which may be derived upon receiving an engine speed and torque request from the REQ 50. In addition, the model may accept other inputs, including a fuel heating value, a fuel conversion efficiency, and the like. Further, the intake controller 46 may also provide functionality to derive a throttle position using a two dimensional (2D) map 61, as previously discussed. The 2D map 61 may accept a desired engine speed and torque as inputs and output the associated throttle position. In some embodiments, the 2D map 61 may include a lookup table that outputs a throttle position given the desired torque and engine speed.

[0019] As discussed in detail below, the intake controller 46 may monitor the throttle position derivation obtained using the model 60 by comparing it to the map 61 based throttle position derivation. If the model 60 based and map 61 based throttle position derivations match within a threshold amount (e.g., any suitable percentage, such as 1%, 2%, 5%, 10%, etc.), then the model 60 based throttle position derivation may be applied to the throttle 14 to produce the desired torque. Specifically, the throttle plate may be set to the determined angle (position) in the throttle body to enable the desired flow of the air-fuel mixture to pass through the throttle 14 to the intake manifold 18 and the cylinders 16 where the air-fuel mixture combusts. The threshold may be calibrated during testing of the throttle 14 during the quality assurance phase of manufacturing, obtained via an external source (e.g., sent from the manufacturer), and/or upon the first start

of the engine 10. If the model 60 based and map 61 based throttle position derivations are not within the calibrated threshold, deviate for a calibrated amount of time, or some combination thereof, then the control system 12 may set a fault and one or more fault response procedures may be triggered. By combining model 60 based and map 61 based control, the techniques described herein may provide for enhanced reliability and control accuracy.

[0020] FIG. 2 illustrates a schematic diagram of the model 60 of a throttle system having the throttle 14 (e.g., throttle valve 14) and connections immediately upstream and downstream of the throttle 14, in accordance with an embodiment. As previously discussed, the model 60 may be a physical (e.g., fluid dynamic) model of the throttle 14. The model 60 may enable the execution of simulations useful in determining what the position (angle) 62 of a throttle plate 64 should be to allow a desired flow of the air-fuel mixture to pass through the throttle 14. The model 60 may simulate the interaction of the air-fuel mixture with surfaces of the throttle 14, such as the throttle body 66 and the throttle plate 64, and various upstream and downstream pressures and temperatures. Further, the model 60 may account for various factors including the air-fuel ratio, heating value of the fuel, and/or engine operation efficiency.

[0021] As illustrated, the model 60 may include inputs for pressure upstream of the throttle 14 (P1), pressure downstream of the throttle 14 at the intake manifold 18 (P2), temperature upstream of the throttle 14 (T1), temperature downstream of the throttle 14 at the intake manifold 18 (T2), and total flow (Q) of air-fuel mixture through the throttle 14. The model 60 may output a desired throttle position 62 (θ) after running a simulation with the inputs to achieve the desired total flow Q through the throttle 14.

[0022] The upstream and downstream pressures (P1 and P2) and temperatures (T1 and T2) may be obtained from data received from the sensors 43. Using the sensor 43 data, the model 60 may adjust the throttle position 62 (θ) based on the upstream and downstream pressures (P1 and P2) and temperatures (T1 and T2). For example, if the upstream pressure P1 is high, the throttle position 62 (θ) may be opened to a larger degree. However, if the intake pressure P1 is low, then the model 60 may derive that the throttle position 62 (θ) may be opened to a lesser degree. Further, the model 60 may account for degradation of certain parts in the engine 10. For example, if fuel actuators are becoming slower, then the pressures P1 and/or P2 may not build up and the sensors 43 may detect the decline in pressures P1 and/or P2 and the model 60 may adjust the throttle position 62 (θ) accordingly. In this way, the model 60 may account for operational conditions and environmental conditions as they change to provide a more accurate throttle position 62 (θ) when running simulations.

[0023] The desired total flow Q may be derived from inputs related to a desired amount of fuel, a desired amount of air, and a desired amount of exhaust gas recirculation (EGR) needed to produce the desired torque. The amount of fuel may be derived by the model 60 using a fuel heating value and the torque that was input by the TQC 50. The fuel heating value relates to the energy in the fuel. Based on the torque and the fuel heating value, the model 60 may derive the amount of fuel. For example, if the fuel heating value is high, then more fuel may be needed to continue to produce the desired torque because the fuel may burn faster, or vice versa. In some embodiments, the fuel heating value may be entered by a user on a human-machine interface (HMI) and/or may be automatically derived using the model 60.

[0024] Then, using the amount of fuel needed and the fuel heating value, the amount of air needed may be derived. For example, to meet certain regulatory emissions requirements, the air-fuel ratio (AFR) may need to be a certain amount (e.g., 40/60, 50/50, 60/40, etc.). Thus, based on the amount of fuel needed, the intake controller 46 may determine the amount of air needed to meet the air-fuel ratio to satisfy the emissions requirements. Therefore, as may be appreciated, the air-fuel ratio depends on the fuel heating value. Further, an amount of EGR may be used in addition to the amount of air and fuel to account for the expected gas exhaust and recirculation of the exhaust back into the intake system. Using the amount of fuel, amount of air, and amount of EGR, the model 60 may derive the total flow Q to use when deriving the throttle position 62 (θ).

[0025] FIG. 3 illustrates a flow diagram of a process 70 suitable for deriving a model based throttle position 62 (θ) and monitoring the model based throttle position 62 (θ) derivation with the derived map 61 based throttle position, in accordance with an embodiment. The process 70 may be implemented as computer instructions stored on the memory 45 and executable by the processor 44. The process 70 may include receiving inputs related to upstream and downstream pressures (P1 and P2) and temperatures (T1 and T2) and a total flow of air-fuel mixture Q (process block 72).

[0026] The process 70 may then derive the throttle position 62 (θ) (process block 74), and monitor the model's derived throttle position 62 (θ) by comparing it to a throttle position derived using the map 61 (process block 76). The process 70 may then raise a fault if the model's derived throttle position 62 (θ) and the map's 61derived throttle position vary by more than a calibrated threshold amount, a threshold calibrated amount of time, or some combination thereof (process block 78). The process 70 may control the position of the throttle 14 using the model based throttle position 62 (θ) derivation if it is within a threshold amount with the map based throttle position derivation (process block 80). That is, the process 70 may first use model-based control, and then compare the position derived via model 60 based control with a map 61 based value to improve reliability.

[0027] Starting with process block 72, the model 60 may receive the upstream and downstream pressures (P1 and P2) and temperatures (T1 and T2) from sensor

43 data and the total flow Q may be derived based on various factors. More specifically, the total flow Q may be derived based on the amount of fuel, amount of air, and/or amount of EGR needed to produce the desired torque. As described in more detail below, the amount of fuel may be determined based on a fuel heating value and a desired torque that is input from the TQC 48. The amount of air needed to combust may be derived based on the amount of fuel needed and an air-fuel ratio (AFR), which may be set based on emission requirements. The model 60 may accept the inputs and derive the throttle position 62 (θ) to apply to the throttle 14 to enable the total flow Q through the throttle 14 (process block 74).

[0028] In process block 76, the process 70 may include monitoring the model based throttle position 62 (θ) derivation by comparing it to the throttle position derived using the 2D map 61 (e.g., lookup table). The 2D map 61 may provide the throttle position given a torque sent by the TQC 48 and a desired engine speed, as previously discussed. If a deviation between the model 60 based and map based throttle position derivation becomes larger than a calibrated threshold, or would be applied for longer than a calibrated threshold amount of time, or both, then a fault may be set (process block 78). The fault being set may trigger one or more fault response procedures.

[0029] The fault response procedures may include using the smaller value for the throttle position between the map 61 based and model 60 based throttle position 62 (θ) derivations, shutting down the engine when the deviation is larger than the calibrated threshold amount and/or the deviation lasts longer than the calibrated amount of time, sending an alert to a workstation, reporting the deviation to the manufacturer to determine if there are situations or locations where throttles do not act as expected (remote monitoring), sounding an alarm, or some combination thereof. As previously discussed, the thresholds may be established during testing of the engine 10. In some embodiments, the thresholds may be calibrated with a sufficient margin so as not to trigger too many faults due to oversensitivity.

[0030] If the model 60 based and map 61 based throttle position derivations are within the calibrated threshold to each other, the model 60 based throttle position 62 (θ) derivation may be used to control the engine 10 load (engine 10 torque) (process block 80). In this way, the techniques leverage the more accurate control of the model 60 based throttle position 62 (θ) derivation while at the same time leverage the robustness of the map 61 based throttle position derivation to crosscheck the results of the model 60 to ensure that a reasonable throttle position 62 (θ) is being derived before applying the derived throttle position 62 (θ) to the throttle 14. This may inhibit the model 60 from deriving a throttle position 62 (θ) that could lead to undesirable maintenance conditions of the engine 10 if the sensors 43 are faulty and providing inaccurate data to the model 60.

[0031] FIGS. 4A and 4B illustrate a schematic diagram of a control system 90 using model 60 based and map 61 based throttle position derivation and monitoring to control engine 10 load, in accordance with an embodiment. The system 90 may include the engine speed and torque requester (REQ) 50, the engine torque controller (TQC) 48, and the intake controller 46, which may apply the map 61 based throttle position derivation and a model 60 based throttle position derivation to control the engine system 10. The REQ 50 may include engine 10 speed and torque set-points. For example, for a desired engine 10 speed, the REQ 50 may provide the respective torque set-point to generate the desired engine 10 speed. In addition the REQ 50 may include loading and de-loading profiles for certain types of loads and engines 10. It should be noted that the system 90 does not need to know anything about the driven application (load). Indeed, the load may be swapped out and the system 90 may account for the switch without knowing exactly which type of load is being driven. That is, using the system 90, the derived throttle 14 position may be made independently without knowledge of the particular application being driven.

[0032] The REQ 50 may provide an engine 10 speed and torque request to the TQC 48. The TQC 48 may receive the torque request and output a torque command 95, which is used by the model 60 based throttle position derivation and the map 61 based throttle position derivation. In some embodiments, the TQC 48 may use a torque loss component 96 to account for friction and the like. The torque request may be adjusted by a speed and torque governor component 98. Further, the TQC 48 may determine whether the trimmed torque request passes a torque rate threshold 100. Fast torques or idle speed may be sent to an ignition controller 102 that is coupled with a fuel conversion efficiency estimator 104 and an ignition module 106. Slow torques may pass through an indicated torque limiter 107 and be output as the torque command 95.

[0033] As illustrated, the model based throttle position derivation may include derivations calculated by applying the model 60, such as derivations obtained from various components, which may include a fuel flow controller (FFC) 108 component, an air flow controller (AFC) 110 component, and a total flow Q controller 112 component, to derive the throttle position 62 (θ). The FFC 108 may accept at least three inputs: the torque command 95 from the TQC 48 for each cylinder, a fuel heating value 114 entered by a user and/or derived automatically, and fuel conversion efficiency estimation 104.

[0034] The FFC 108 may use the torque command 95, fuel heating value 114, and the fuel conversion efficiency estimation 104 to derive an amount of fuel that may be needed during combustion in each cylinder to produce the desired torque. The FFC 108 may output the torque and the derived amount of fuel needed at each cylinder to the AFC 110, the total flow Q controller 112, and fuel actuators 116. The fuel actuators 116 may inject the fuel into the engine 10 as requested. It should be noted that the control system 90 may take into account a fuel trans-

port delay 117 between the actuators 116 to the cylinders. Further, the control system 90 may include an air-fuel ratio (AFR) fuel trim component 118 that may reduce the amount and/or flow of fuel injected into the engine 10 based on certain emission requirements.

[0035] Using the amount of fuel requested and desired torque, the AFC 110 may derive the amount of air needed in the cylinders for proper combustion based on an air-fuel ratio (AFR) set point 119. For example, if the AFR set point 119 is 50%, then the AFC 110 may determine that the air-fuel mixture has to include 50% fuel and 50% air. Thus, in this example, the same amount of air must be used as the requested amount of fuel to achieve the AFR set point 119. In some embodiments, the AFR set point 119 may be set according to regulatory emissions requirements. The AFC 110 may output the amount of air at each cylinder and desired torque to the total flow Q controller 112.

[0036] Also, in some embodiments, the total flow Q controller 112 may accept input from an EGR flow controller 120. The EGR flow controller 120 may account for the expected gas exhaust and derive the amount of EGR to pass back through the intake system. The EGR flow controller 120 may send an EGR request to an EGR valve controller 122 to control the amount of EGR as determined.

[0037] Using the amount of fuel requested from the FFC 108, amount of air requested from the AFC 110, and/or the amount of EGR requested from the EGR flow controller 120, the total flow Q controller 112 may derive the desired total flow Q to pass through the throttle 14. The model 60 may use the total flow Q, along with upstream and downstream pressures (P1 and P2) and temperatures (T1 and T2) to derive the throttle position 62 (θ) by running simulations to determine which position enables the desired total flow Q to more optimally traverse a physical (fluid dynamic) model 60 of the throttle 14.

[0038] As illustrated, the map 61 based throttle position derivation may be used to monitor the model 60 based throttle position derivation. The map 61 may receive the torque command 95 from the TQC 48 as well as a desired engine speed 124 as inputs and may derive the associated throttle position. As previously discussed, the map 61 may not use sensor data to derive the throttle position and may include a look-up table with associated torques, engine speeds, and throttle positions. The map 61 may be two dimensional (2D) because it accepts two inputs: torque 95 and engine speed 124. The system 90 may continuously, periodically, or some combination thereof, compare the map 61 based throttle position derivation with the model 60 based throttle 14 position derivation to check whether the derivations are within calibrated thresholds of each other. If the derivations are not within the calibrated thresholds, the system 90 may perform one or more fault response procedures as discussed above.

[0039] Technical effects of the disclosure include deriving a more accurate throttle 14 position using a model 60 based approach and crosschecking the accuracy of the model 60 using a throttle position derived using a 2D map 61. The model 60 of the throttle 14 may account for various factors, such as upstream and downstream pressures (P1 and P2) and temperatures (T1 and T2), fuel heating values 114, engine operation efficiency (fuel conversion efficiency 104), and so forth. The data related to the pressures (P1 and P2) and temperatures (T1 and T2) may be obtained via one or more sensors 43 and, thus, enables the model 60 to adjust for environmental and operational conditions as they change. By using the map 61 based throttle 14 position derivation, the techniques are able to crosscheck the model 60 based throttle 14 position derivation and set faults when certain calibrated thresholds are not met. In this way, the techniques leverage the better control obtained from the model 60 based throttle 14 position derivation while still maintaining the robustness of the map 61 based throttle 14 position derivation.

[0040] This written description uses examples to disclose the present techniques, including the best mode, and also to enable any person skilled in the art to practice the techniques, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the disclosure is defined by the claims.

Claims

1. An engine system (10), comprising:
an engine control system (12) configured to:

receive a first pressure signal (P_2) transmitted from a first pressure sensor (43) disposed downstream from a throttle valve (14);
receive a first temperature signal (T_2) transmitted from a first temperature sensor (43) disposed downstream from the throttle valve (14);
derive a first pressure representative of the first pressure signal;
derive a first temperature representative of the first temperature signal;
derive a desired air-fuel mixture flow through the throttle valve (14);
derive a first throttle position using a model (60), wherein the model (60) is configured to use the desired air-fuel mixture flow, the first pressure (P_2), and the first temperature (T_2) as model input;
derive a second throttle (62) position using a map (61);
compare the first throttle position to the second throttle position; and
apply the first throttle (62) position to control the throttle valve (14) when the first throttle position and the second throttle position are within one

or more calibrated thresholds,

wherein the engine control system comprises an engine control unit (ECU), and wherein the ECU is configured to:

receive a second pressure signal (P_1) transmitted from a second pressure sensor (43) disposed upstream from the throttle valve (14);
receive a second temperature signal (T_1) transmitted from a second temperature sensor (43) disposed upstream from the throttle valve (14);
derive a second pressure (P_1) representative of the second pressure signal; and
derive a second temperature (T_1) representative of the second temperature signal, wherein the model (60) is configured to use the first and the second pressure (P_1,P_2) and the first and the second temperature (T_1,T_2) as model input to derive the first throttle position (62),

and wherein the map (61) comprises a lookup table that maps a desired engine torque and an engine speed to the second throttle position.

2. The engine system of claim 1, wherein the model (60) comprises a fluid dynamic model of a throttle system having the throttle valve (14).

3. The engine system of any of claims 1 or 2, wherein the engine control system (12) is configured to derive the desired air-fuel mixture flow (Q) based on a desired fuel amount, a desired air amount, and a desired exhaust gas recirculation amount.

4. The engine system of claim 3, wherein the engine control system (12) is configured to derive the desired fuel amount based on a desired engine torque, a fuel heating value, a fuel conversion efficiency, or some combination thereof.

5. The engine system of claim 4, wherein the fuel heating value is provided by a user or automatically derived via a sampling of a fuel.

6. The engine system of any preceding claim, wherein the one or more calibrated thresholds comprise a threshold difference between the first and the second throttle position, a threshold amount of time that the first and the second throttle position deviate, or a combination thereof.

7. The engine system of claim 6, wherein the engine control system (12) is configured to apply the smaller of the first throttle position or the second throttle position if the first and the second throttle positions are not within the one or more calibrated thresholds.

8. The engine system of any of claims 3 to 7, wherein the engine control system (12) is configured to derive the desired air amount based on an air-fuel ratio and the desired fuel amount, and wherein the engine control system (12) is configured to actuate an actuator (116) to provide the desired air amount.

9. The engine system of any preceding claim, wherein the engine control system (12) is configured to report a deviation between the first and the second throttle positions, shut down an engine (10) having the throttle valve (14), raising an alert or an alarm, or a combination thereof, if the first and the second throttle positions are not within the one or more calibrated thresholds.

10. A method, comprising:

receiving, via a processor (44), a first pressure signal transmitted from a first pressure sensor (43) disposed downstream from a throttle valve (14);
receiving, via the processor (44), a first temperature signal transmitted from a first temperature sensor (43) disposed downstream from the throttle valve (14);
deriving, via the processor (44), a first pressure (P_2) representative of the first pressure signal;
deriving, via the processor (44), a first temperature (T_2) representative of the first temperature signal;
deriving, via the processor (44), a desired air-fuel mixture (Q) flow through the throttle valve (14);
deriving, via the processor (44), a first throttle position (62) using a model (60), wherein the model (60) is configured to use the desired air-fuel mixture flow (Q), the first pressure (P_2), and the first temperature (T_2) as model input;
deriving, via the processor (44), a second throttle position using a map (61), wherein the map comprises a lookup table that maps a desired engine torque and an engine speed to the second throttle position;
comparing, via the processor (44), the first throttle position to the second throttle position; and
applying, via the processor (44), the first throttle position to control the throttle valve (14) when the first throttle position and the second throttle position are within one or more calibrated thresholds,
the method further comprising:
receiving, via the processor (44), a second pressure signal transmitted from a second pressure sensor (43) disposed upstream from the throttle valve (14);

receiving, via the processor (44), a second

temperature signal transmitted from a second temperature sensor (43) disposed upstream from the throttle valve (14);
deriving, via the processor (43), a second pressure (P1) representative of the second pressure signal (14); and

deriving, via the processor (44), a second temperature (T1) representative of the second temperature signal, wherein the model (60) is configured to use the first and the second pressure (P2,P1) and the first and the second temperature (T2,T1) as model input to derive the first throttle position

11. The method of claim 10, wherein the model (60) comprises a fluid dynamic model of a throttle system having the throttle valve (14).

12. The method of claim 10 or 11, comprising:
deriving the desired air-fuel mixture flow based on a desired fuel amount, a desired air amount, and a desired exhaust gas recirculation amount.

Patentansprüche

1. Motorsystem (10), das Folgendes umfasst:

ein Motorsteuerungssystem (12), das zu Folgendem konfiguriert ist:

ein erstes Drucksignal (P_2) zu empfangen, das von einem ersten Drucksensor (43) übermittelt wird, der stromabwärts von einer Drosselklappe (14) angeordnet ist,
ein erstes Temperatursignal (T_2) zu empfangen, das von einem ersten Temperatursensor (43) übermittelt wird, der stromabwärts von der Drosselklappe (14) angeordnet ist,
einen ersten Druck abzuleiten, der das erste Drucksignal darstellt,
eine erste Temperatur abzuleiten, die das erste Temperatursignal darstellt,
einen gewünschten Kraftstoff-Luft-Gemisch-Durchfluss durch die Drosselklappe (14) abzuleiten,
eine erste Drosselstellung unter Verwendung eines Modells (60) abzuleiten, wobei das Modell (60) dafür konfiguriert ist, den gewünschten Kraftstoff-Luft-Gemisch-Durchfluss, den ersten Druck (P_2) und die erste Temperatur (T_2) als Modelleingabe zu verwenden,
eine zweite Drosselstellung (62) unter Verwendung eines Kennfeldes (61) abzuleiten, die erste Drosselstellung mit der zweiten Drosselstellung zu vergleichen und
die erste Drosselstellung (62) anzuwenden, um die Drosselklappe (14) zu steuern, wenn die erste Drosselstellung und die zweite Drosselstellung innerhalb eines oder mehrerer geeichter Schwellenwert liegen,

wobei das Motorsteuerungssystem eine Motorsteuereinheit (engine control unit - ECU) umfasst und wobei die ECU zu Folgendem konfiguriert ist:

ein zweites Drucksignal (P_1) zu empfangen, das von einem zweiten Drucksensor (43) übermittelt wird, der stromaufwärts von einer Drosselklappe (14) angeordnet ist,
ein zweites Temperatursignal (T_1) zu empfangen, das von einem zweiten Temperatursensor (43) übermittelt wird, der stromaufwärts von der Drosselklappe (14) angeordnet ist,
einen zweiten Druck (P_1) abzuleiten, der das zweite Drucksignal darstellt, und
eine zweite Temperatur (T_1) abzuleiten, die das zweite Temperatursignal darstellt, wobei das Modell (60) dafür konfiguriert ist, den ersten und den zweiten Druck (P_1, P_2) und die erste und die zweite Temperatur (T_1, T_2) als Modelleingabe zu verwenden, um die erste Drosselstellung (62) abzuleiten,

und wobei das Kennfeld (61) eine Nachschlagetabelle umfasst, die ein gewünschtes Motordrehmoment und eine Motordrehzahl auf die zweite Drosselstellung abbildet.

2. Motorsystem nach Anspruch 1, wobei das Modell (60) ein fluiddynamisches Modell eines Drosselsystems, das die Drosselklappe (14) aufweist, umfasst.

3. Motorsystem nach einem der Ansprüche 1 oder 2, wobei das Motorsteuerungssystem (12) dafür konfiguriert ist, den gewünschten Kraftstoff-Luft-Gemisch-Durchfluss (Q) auf der Grundlage einer gewünschten Kraftstoffmenge, einer gewünschten Luftmenge und einer gewünschten Abgasrückführungsmenge abzuleiten.

4. Motorsystem nach Anspruch 3, wobei das Motorsteuerungssystem (12) dafür konfiguriert ist, die gewünschte Kraftstoffmenge auf der Grundlage eines gewünschten Motordrehmoments, eines Kraftstoff-Brennwertes, eines Kraftstoff-Umwandlungswirkungsgrades oder einer Kombination derselben abzuleiten.

5. Motorsystem nach Anspruch 4, wobei der Kraftstoff-

Brennwert durch einen Benutzer bereitgestellt oder automatischen über ein Probenehmen des Kraftstoffs abgeleitet wird.

6. Motorsystem nach einem der vorhergehenden Ansprüche, wobei der eine oder die mehreren geeichten Schwellenwerte eine Schwellendifferenz zwischen der ersten und der zweiten Drosselstellung, ein Schwellenzeitmaß, um das die erste und die zweite Drosselstellung abweichen oder eine Kombination derselben umfassen.

7. Motorsystem nach Anspruch 6, wobei das Motorsteuerungssystem (12) dafür konfiguriert ist, die kleinere von der ersten Drosselstellung oder der zweiten Drosselstellung anzuwenden, falls die erste und die zweite Drosselstellung nicht innerhalb des einen oder der mehreren geeichten Schwellenwerte liegen.

8. Motorsystem nach einem der Ansprüche 3 bis 7, wobei das Motorsteuerungssystem (12) dafür konfiguriert ist, die gewünschte Luftmenge auf der Grundlage eines Kraftstoff-Luft-Verhältnisses und der gewünschten Kraftstoffmenge abzuleiten, und wobei das Motorsteuerungssystem (12) dafür konfiguriert ist, einen Stellantrieb (116) zu betätigen, um die gewünschte Luftmenge bereitzustellen.

9. Motorsystem nach einem der vorhergehenden Ansprüche, wobei das Motorsteuerungssystem (12) dafür konfiguriert ist, eine Abweichung zwischen der ersten und der zweiten Drosselstellung zu melden, einen Motor (10) abzuschalten, der die Drosselklappe (14) aufweist, eine Warnung oder einen Alarm zu verursachen oder eine Kombination davon, falls die erste und die zweite Drosselstellung nicht innerhalb des einen oder der mehreren geeichten Schwellenwerte liegen.

10. Verfahren, das Folgendes umfasst:

Empfangen, über einen Prozessor (44), eines ersten Drucksignals, das von einem ersten Drucksensor (43) übermittelt wird, der stromabwärts von einer Drosselklappe (14) angeordnet ist,
Empfangen, über den Prozessor (44), eines ersten Temperatursignals, das von einem ersten Temperatursensor (43) übermittelt wird, der stromabwärts von der Drosselklappe (14) angeordnet ist,
Ableiten, über den Prozessor (44), eines ersten Drucks (P_2), der das erste Drucksignal darstellt,
Ableiten, über den Prozessor (44), einer ersten Temperatur (T_2), die das erste Temperatursignal darstellt,
Ableiten, über den Prozessor (44), eines gewünschten Kraftstoff-Luft-Gemisch-Durchflusses (Q) durch die Drosselklappe (14),
Ableiten, über den Prozessor (44), einer ersten Drosselstellung (62) unter Verwendung eines Modells (60), wobei das Modell (60) dafür konfiguriert ist, den gewünschten Kraftstoff-Luft-Gemisch-Durchfluss (Q), den ersten Druck (P_2) und die erste Temperatur (T_2) als Modelleingabe zu verwenden,
Ableiten, über den Prozessor (44), einer zweiten Drosselstellung unter Verwendung eines Kennfeldes (61), wobei das Kennfeld eine Nachschlagetabelle umfasst, die ein gewünschtes Motordrehmoment und eine Motordrehzahl auf die zweite Drosselstellung abbildet,
Vergleichen, über den Prozessor (44), der ersten Drosselstellung mit der zweiten Drosselstellung und
Anwenden, über den Prozessor (44), der ersten Drosselstellung, um die Drosselklappe (14) zu steuern, wenn die erste Drosselstellung und die zweite Drosselstellung innerhalb eines oder mehrerer geeichter Schwellenwert liegen,
wobei das Verfahren ferner Folgendes umfasst:

Empfangen, über den Prozessor (44), eines zweiten Drucksignals, das von einem zweiten Drucksensor (43) übermittelt wird, der stromaufwärts von einer Drosselklappe (14) angeordnet ist,
Empfangen, über den Prozessor (44), eines zweiten Temperatursignals, das von einem zweiten Temperatursensor (43) übermittelt wird, der stromaufwärts von der Drosselklappe (14) angeordnet ist,
Ableiten, über den Prozessor (43), eines zweiten Drucks (P1), der das zweite Drucksignal (14) darstellt, und
Ableiten, über den Prozessor (44), einer zweiten Temperatur (T1), die das zweite Temperatursignal darstellt, wobei das Modell (60) dafür konfiguriert ist, den ersten und den zweiten Druck (P2, P2) und die erste und die zweite Temperatur (T2, T1) als Modelleingabe zu verwenden, um die erste Drosselstellung abzuleiten.

11. Verfahren nach Anspruch 10, wobei das Modell (60) ein fluiddynamisches Modell eines Drosselsystems, das die Drosselklappe (14) aufweist, umfasst.

12. Verfahren nach Anspruch 10 oder 11, das Folgendes umfasst:
Ableiten des gewünschten Kraftstoff-Luft-Gemisch-Durchflusses auf der Grundlage einer gewünschten Kraftstoffmenge, einer gewünschten Luftmenge und einer gewünschten Abgasrückführungsmenge.

Revendications

1. Système de moteur (10), comprenant :

un système de commande de moteur (12), configuré pour :

recevoir un premier signal de pression (P_2) transmis depuis un premier capteur de pression (43) disposé en aval d'un clapet d'étranglement (14) ;
recevoir un premier signal de température (T_2) transmis depuis un premier capteur de température (43) disposé en aval du clapet d'étranglement (14)
dériver une première pression représentative du premier signal de pression ;
dériver une première température représentative du premier signal de température ;
dériver un flux de mélange air-carburant souhaité à travers le clapet d'étranglement (14) ;
dériver une première position d'étranglement en utilisant un modèle (60), le modèle (60) étant configuré pour utiliser le flux de mélange air-carburant souhaité, la première pression (P_2) et la première température (T_2) en tant qu'entrée du modèle ;
dériver une deuxième position d'étranglement (62) en utilisant une carte (61) ;
comparer la première position d'étranglement avec la deuxième position d'étranglement ; et
appliquer la première position d'étranglement (62) pour commander le clapet d'étranglement (14) lorsque la première position d'étranglement et la deuxième position d'étranglement sont à l'intérieur d'un ou plusieurs seuils étalonnés,

le système de commande de moteur comprenant une unité de commande de moteur (ECU), et l'ECU étant configurée pour :

recevoir un deuxième signal de pression (P_1) transmis depuis un deuxième capteur de pression (43) disposé en amont du clapet d'étranglement (14) ;
recevoir un deuxième signal de température (T_1) transmis depuis un deuxième capteur de température (43) disposé en amont du clapet d'étranglement (14) ;
dériver une deuxième pression (P_1) représentative du deuxième signal de pression ; et
dériver une deuxième température (T_1) représentative du deuxième signal de température, le modèle (60) étant configuré pour utiliser la première et la deuxième pression (P_1, P_2) et la première et la deuxième température (T_1, T_2) en tant qu'entrée du modèle pour dériver la première position d'étranglement (62),

et la carte (61) comprenant une table à consulter qui mappe un couple moteur souhaité et une vitesse du moteur à la deuxième position d'étranglement.

2. Système de moteur selon la revendication 1, dans lequel le modèle (60) comprend un modèle dynamique des fluides d'un système d'étranglement ayant le clapet d'étranglement (14).

3. Système de moteur selon l'une quelconque des revendications 1 ou 2, dans lequel le système de commande de moteur (12) est configuré pour dériver le flux du mélange air-carburant souhaité (Q) sur la base d'une quantité de carburant souhaitée, d'une quantité d'air souhaitée, et d'une quantité de recirculation de gaz d'échappement souhaitée.

4. Système de moteur selon la revendication 3, dans lequel le système de commande de moteur (12) est configuré pour dériver la quantité de carburant souhaitée sur la base d'un couple moteur souhaité, d'une valeur de chauffage de carburant, d'un rendement de conversion de carburant, ou d'une combinaison de ceux-ci.

5. Système de moteur selon la revendication 4, dans lequel la valeur de chauffage de carburant est fournie par un utilisateur ou est dérivée automatiquement par le biais d'un échantillonnage d'un carburant.

6. Système de moteur selon l'une quelconque des revendications précédentes, dans lequel le ou les seuils étalonnés comprennent une différence de seuil entre la première et la deuxième position d'étranglement, une quantité de temps de seuil suivant laquelle la première et la deuxième position d'étranglement diffèrent ou une combinaison de ceux-ci.

7. Système de moteur selon la revendication 6, dans lequel le système de commande de moteur (12) est configuré pour appliquer la plus petite, parmi la première position d'étranglement et la deuxième position d'étranglement, si la première et la deuxième position d'étranglement ne sont pas à l'intérieur du ou des seuils étalonnés.

8. Système de moteur selon l'une quelconque des revendications 3 à 7, dans lequel le système de commande de moteur (12) est configuré pour dériver la

quantité d'air souhaitée sur la base d'un rapport air-carburant et de la quantité de carburant souhaitée, et dans lequel le système de commande de moteur (12) est configuré pour actionner un actionneur (116) pour fournir la quantité d'air souhaitée.

9. Système de moteur selon l'une quelconque des revendications précédentes, dans lequel le système de commande de moteur (12) est configuré pour signaler un écart entre la première et la deuxième position d'étranglement, arrêter un moteur (10) ayant le clapet d'étranglement (14), déclencher une alerte ou une alarme, ou une combinaison des deux, si la première et la deuxième position d'étranglement ne sont pas à l'intérieur du ou des seuils étalonnés.

10. Procédé comprenant les étapes consistant à :

recevoir, par le biais d'un processeur (44), un premier signal de pression transmis depuis un premier capteur de pression (43) disposé en aval d'un clapet d'étranglement (14) ;
recevoir, par le biais du processeur (44), un premier signal de température transmis depuis un premier capteur de température (43) disposé en aval du clapet d'étranglement (14) ;
dériver, par le biais du processeur (44), une première pression (P_2) représentative du premier signal de pression ;
dériver, par le biais du processeur (44), une première température (T_2) représentative du premier signal de température ;
dériver, par le biais du processeur (44) un flux de mélange air-carburant souhaité (Q) à travers le clapet d'étranglement (14) ;
dériver, par le biais du processeur (44), une première position d'étranglement (62) en utilisant un modèle (60), le modèle (60) étant configuré pour utiliser le flux de mélange air-carburant souhaité (Q), la première pression (P_2) et la première température (T_2) en tant qu'entrée du modèle ;
dériver, par le biais du processeur (44), une deuxième position d'étranglement en utilisant une carte (61), la carte comprenant une table à consulter qui mappe un couple moteur souhaité et une vitesse du moteur à la deuxième position d'étranglement ;
comparer, par le biais du processeur (44), la première position d'étranglement avec la deuxième position d'étranglement ; et
appliquer, par le biais du processeur (44), la première position d'étranglement pour commander le clapet d'étranglement (14) lorsque la première position d'étranglement et la deuxième position d'étranglement sont à l'intérieur d'un ou plusieurs seuils étalonnés,
le procédé comprenant en outre les étapes consistant à :

recevoir, par le biais du processeur (44), un deuxième signal de pression transmis depuis un deuxième capteur de pression (43) disposé en amont du clapet d'étranglement (14) ;
recevoir, par le biais du processeur (44) un deuxième signal de température transmis depuis un deuxième capteur de température (43) disposé en amont du clapet d'étranglement (14) ;
dériver, par le biais du processeur (43), une deuxième pression (P1) représentative du deuxième signal de pression (14) ; et
dériver, par le biais du processeur (44), une deuxième température (T1) représentative du deuxième signal de température, le modèle (60) étant configuré pour utiliser la première et la deuxième pression (P2, P1) et la première et la deuxième température (T2, T1) en tant qu'entrée du modèle pour dériver la première position d'étranglement.

11. Procédé selon la revendication 10, dans lequel le modèle (60) comprend un modèle dynamique des fluides d'un système d'étranglement ayant le clapet d'étranglement (14).

12. Procédé selon la revendication 10 ou 11, comprenant l'étape consistant à :
dériver le flux de mélange air-carburant souhaité sur la base d'une quantité de carburant souhaitée, d'une quantité d'air souhaitée, et d'une quantité de recirculation de gaz d'échappement souhaitée.

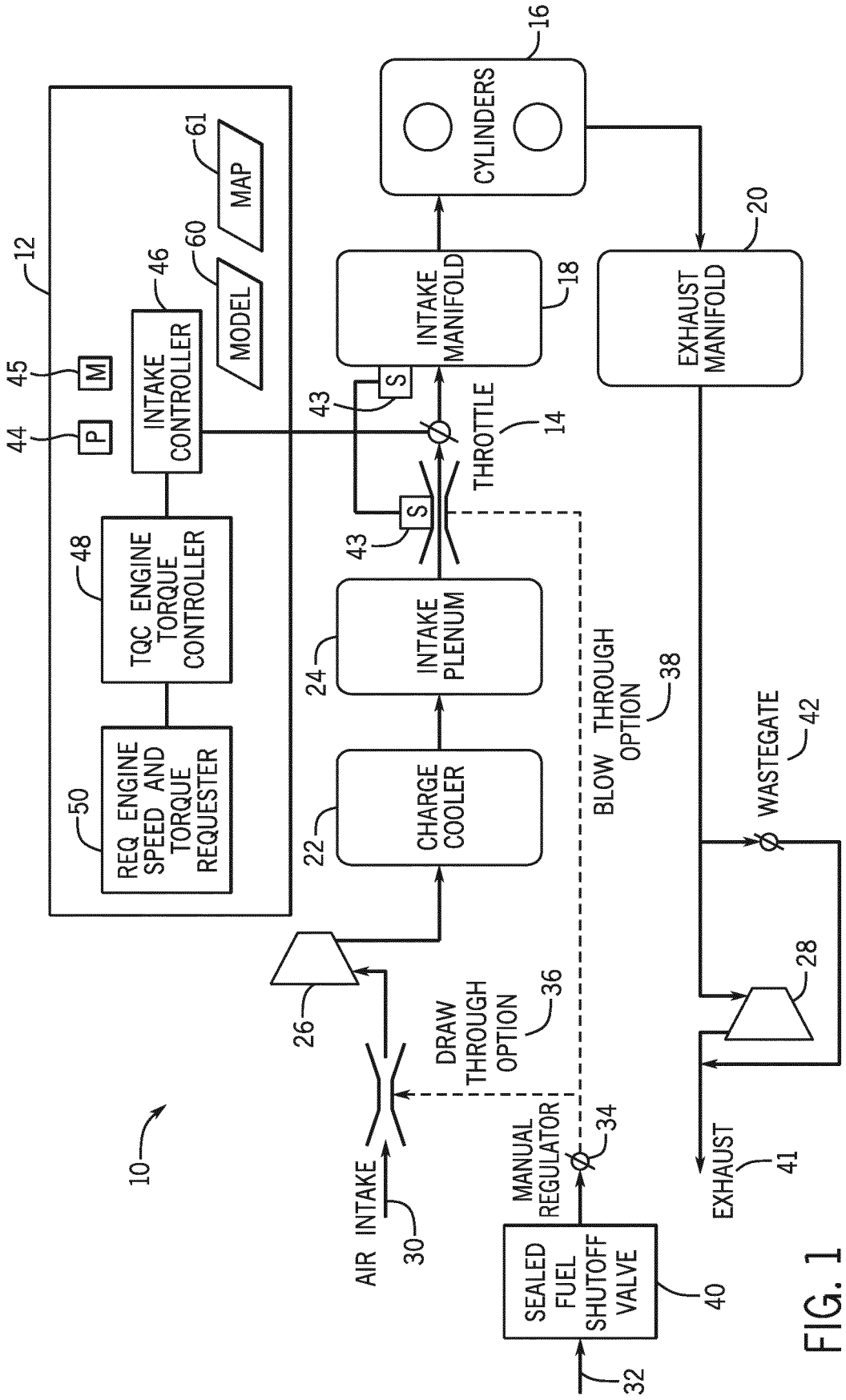
10
12
16
CYLINDERS
61
MAP
60
MODEL
46
INTAKE CONTROLLER
45
M
44
P
48
TQC ENGINE TORQUE CONTROLLER
50
REQ ENGINE SPEED AND TORQUE REQUESTER
18
INTAKE MANIFOLD
20
EXHAUST MANIFOLD
43
S
THROTTLE
14
24
INTAKE PLENUM
22
CHARGE COOLER
BLOW THROUGH OPTION
38
WASTEGATE
42
26
DRAW THROUGH OPTION
36
28
AIR INTAKE
30
MANUAL REGULATOR
34
EXHAUST
41
SEALED FUEL SHUTOFF VALVE
40
32

FIG. 1

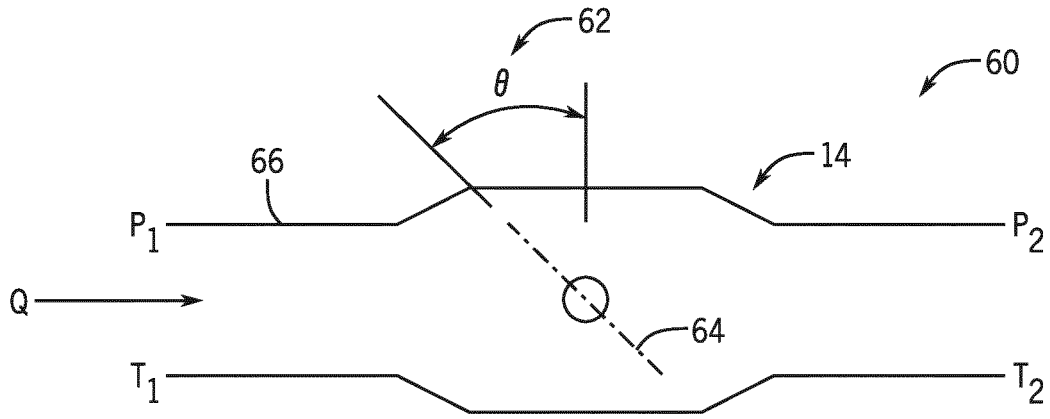
62
θ
60
66
14
P1
P2
Q
64
T1
T2

FIG. 2

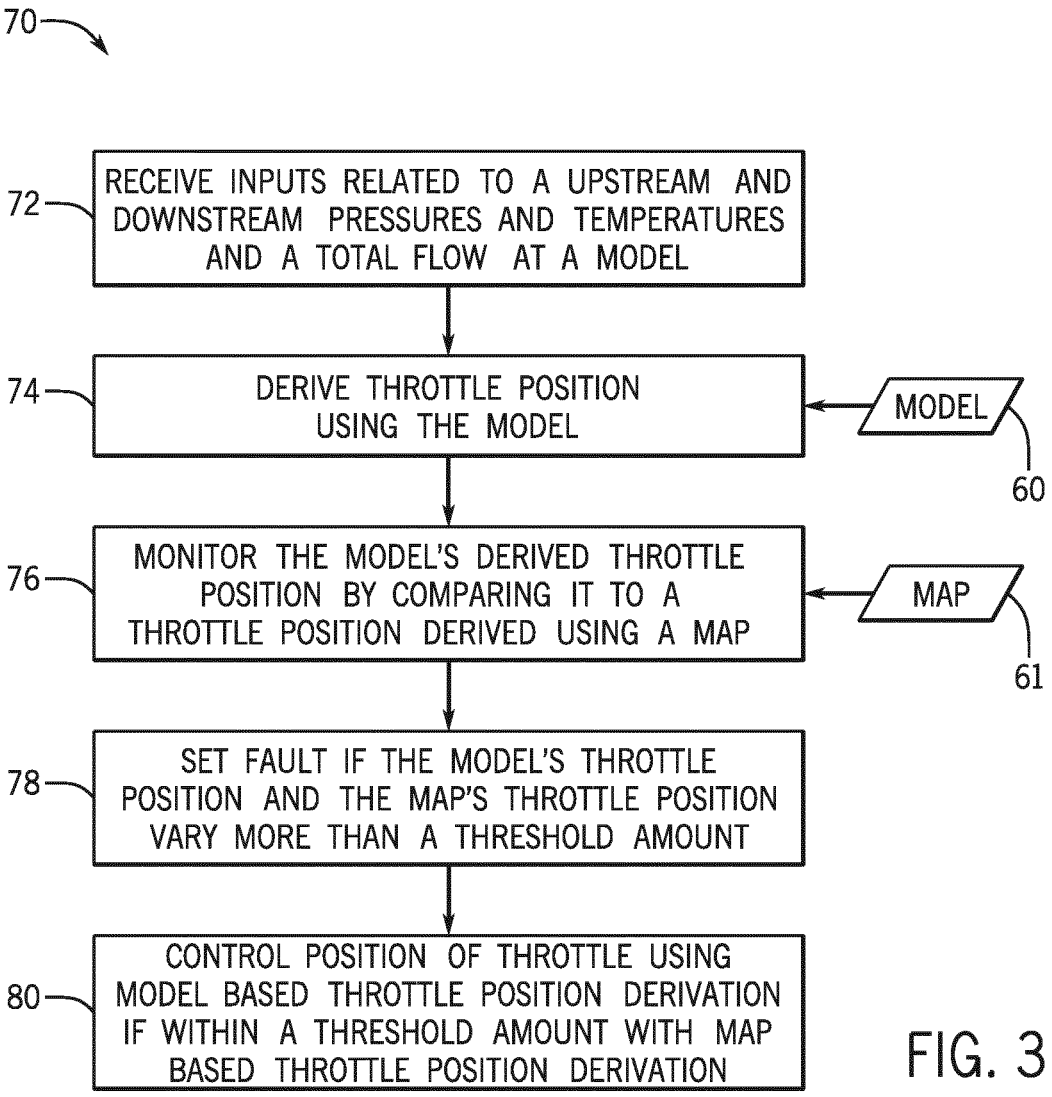
70
72
RECEIVE INPUTS RELATED TO A UPSTREAM AND DOWNSTREAM PRESSURES AND TEMPERATURES AND A TOTAL FLOW AT A MODEL
74
DERIVE THROTTLE POSITION USING THE MODEL
MODEL
60
76
MONITOR THE MODEL'S DERIVED THROTTLE POSITION BY COMPARING IT TO A THROTTLE POSITION DERIVED USING A MAP
MAP
61
78
SET FAULT IF THE MODEL'S THROTTLE POSITION AND THE MAP'S THROTTLE POSITION VARY MORE THAN A THRESHOLD AMOUNT
80
CONTROL POSITION OF THROTTLE USING MODEL BASED THROTTLE POSITION DERIVATION IF WITHIN A THRESHOLD AMOUNT WITH MAP BASED THROTTLE POSITION DERIVATION

FIG. 3

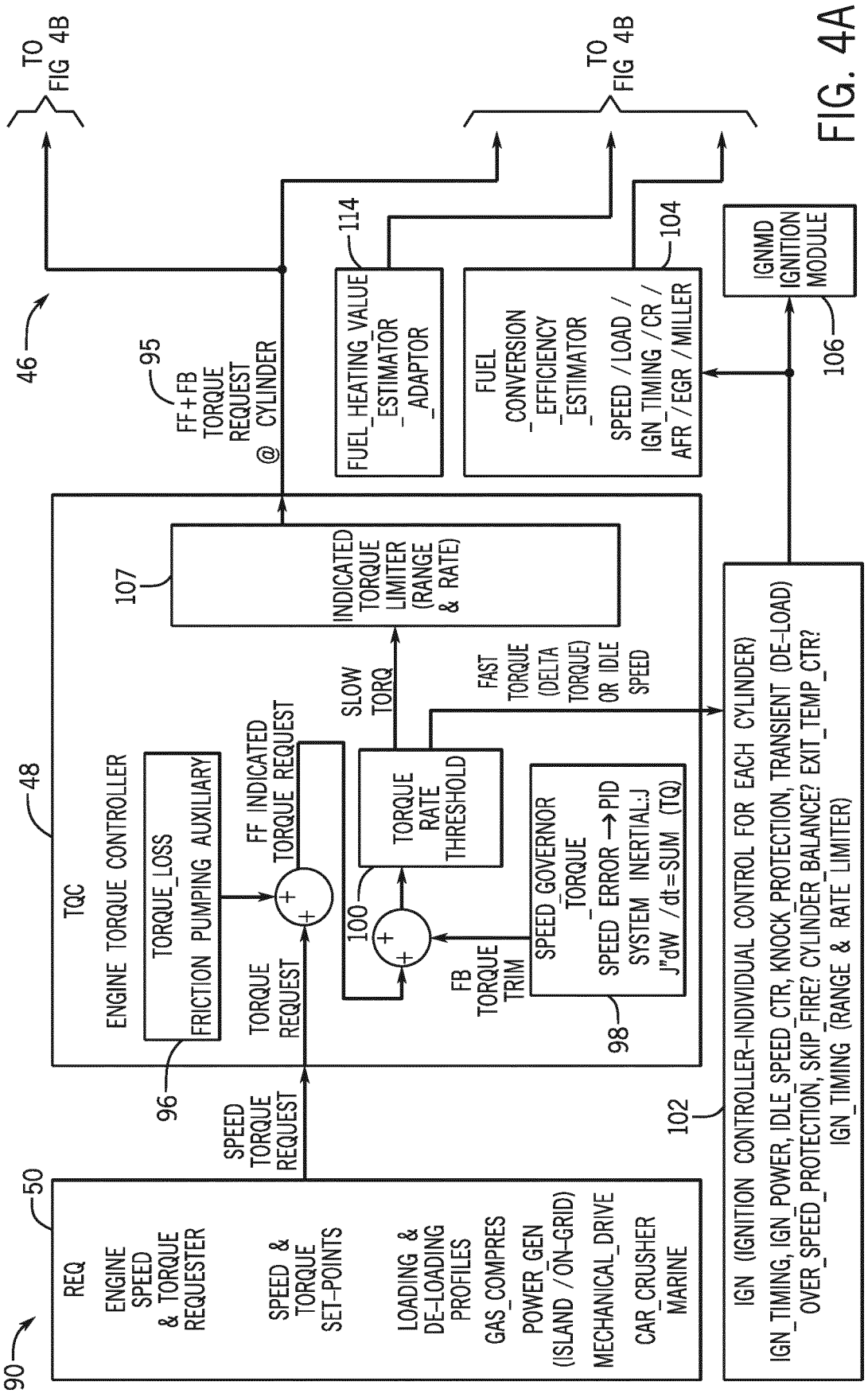
90
50
REQ
ENGINE SPEED & TORQUE REQUESTER
SPEED & TORQUE SET-POINTS
LOADING & DE-LOADING PROFILES
GAS_COMPRES
POWER_GEN (ISLAND /ON-GRID)
MECHANICAL_DRIVE
CAR_CRUSHER MARINE
SPEED TORQUE REQUEST
48
TQC
ENGINE TORQUE CONTROLLER
TORQUE_LOSS
FRICTION PUMPING AUXILIARY
96
TORQUE REQUEST
FF INDICATED TORQUE REQUEST
100
TORQUE RATE THRESHOLD
SLOW TORQ
FAST TORQUE (DELTA TORQUE) OR IDLE SPEED
FB TORQUE TRIM
SPEED_GOVERNOR _TORQUE
SPEED_ERROR → PID
SYSTEM INERTIAL:J
J"dW /dt=SUM (TQ)
98
107
INDICATED TORQUE LIMITER (RANGE & RATE)
95
FF+FB TORQUE REQUEST @ CYLINDER
46
TO FIG 4B
114
FUEL_HEATING_VALUE _ESTIMATOR _ADAPTOR
FUEL _CONVERSION _EFFICIENCY _ESTIMATOR
104
SPEED /LOAD / IGN_TIMING /CR / AFR /EGR /MILLER
IGNMD IGNITION MODULE
106
102
IGN (IGNITION CONTROLLER-INDIVIDUAL CONTROL FOR EACH CYLINDER)
IGN_TIMING, IGN_POWER, IDLE_SPEED_CTR, KNOCK_PROTECTION, TRANSIENT (DE-LOAD)
OVER_SPEED_PROTECTION, SKIP_FIRE? CYLINDER_BALANCE? EXIT_TEMP_CTR?
IGN_TIMING (RANGE & RATE_LIMITER)

FIG. 4A

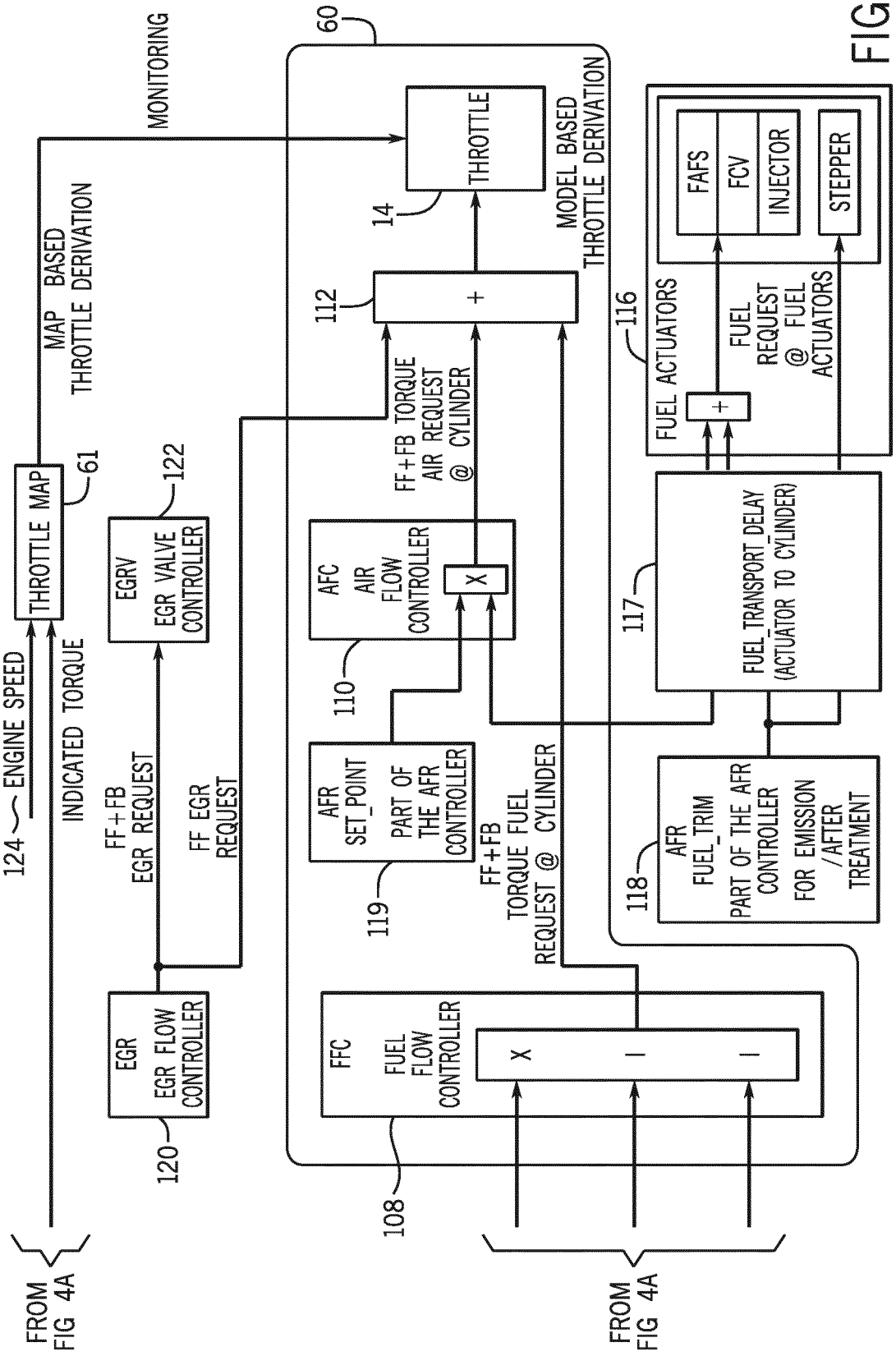
FROM FIG 4A
ENGINE SPEED
INDICATED TORQUE
THROTTLE MAP
61
MAP BASED THROTTLE DERIVATION
MONITORING
60
THROTTLE
14
MODEL BASED THROTTLE DERIVATION
112
+
FF+FB TORQUE AIR REQUEST @ CYLINDER
AFC AIR FLOW CONTROLLER
110
X
EGRV EGR VALVE CONTROLLER
122
FF+FB EGR REQUEST
FF EGR REQUEST
EGR EGR FLOW CONTROLLER
120
AFR SET_POINT PART OF THE AFR CONTROLLER
119
FF+FB TORQUE FUEL REQUEST @ CYLINDER
FFC FUEL FLOW CONTROLLER
X
I
I
108
FUEL ACTUATORS
116
FAFS
FCV
INJECTOR
STEPPER
+
FUEL REQUEST @ FUEL ACTUATORS
117
FUEL_TRANSPORT_DELAY (ACTUATOR TO CYLINDER)
118
AFR FUEL_TRIM PART OF THE AFR CONTROLLER FOR EMISSION /AFTER TREATMENT
FROM FIG 4A

FIG. 4B

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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